A Quantitative Analysis of the Diet of Southwestern Willow Flycatchers in the Gila Valley, New Mexico

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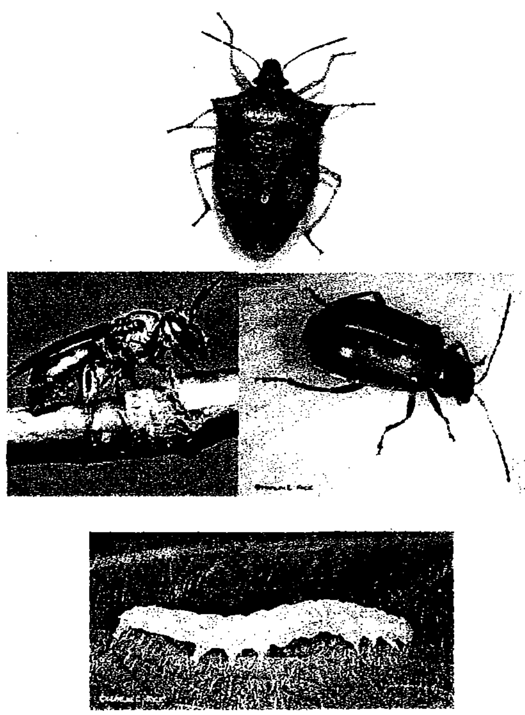

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Abstract

Food habits of the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*) remain only poorly known. Two previous descriptive studies conducted in Arizona, Colorado, and California reported a wide range of arthropod prey taken, but it is unclear yet whether the bird should be considered a generalist insectivore. We present information on diet of Willow Flycatchers in the Cliff-Gila Valley, New Mexico, based on 23 fecal samples. Birds at that large breeding site ate a variety of prey taxa, predominately bees and wasps, but also substantial amounts of true bugs, true flies, and beetles. Proportions of arthropod taxa in the Gila diet differed from those at sites in Arizona and California. We used sticky traps to sample the arthropod community in three riparian patches on the Gila that varied in density of flycatchers and amount of water. Little difference was found among the three sites; what variation there was in arthropod abundance did not correspond to flycatcher densities. Because the flycatcher diet on the Gila was more similar to diets elsewhere in the Southwest than it was to the general arthropod community on the Gila, we suggest that the Southwestern Willow Flycatcher may be a diet specialist rather than a generalist. As such, there is the potential for the subspecies to be subject to food limitation.

Introduction

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*) is a riparian obligate inhabiting dense streamside thickets and woodland (Sedgwick 2000, Sogge and Marshall 2000). In the past century, most of the riparian habitat in the Southwest has been destroyed or degraded due to urban and agricultural development, water management, channelization, overgrazing, recreation, and invasion by exotic saltcedar (*Tamarix ramosissima*) (Patten 1998, Cartron et al. 2000, Marshall and Stoleson 2000). The Southwestern Willow Flycatcher has shown a concomitant decline (Unitt 1987), resulting in it being listed as an endangered species in 1995 (U.S. Fish and Wildlife Service 1995). The most recent population estimates total 915 known territories rangewide (U.S. Fish and Wildlife Service 2001).

Although recent research has shed light on various aspects of Willow Flycatcher biology and habitat associations (see Finch and Stoleson 2000, U.S. Fish and Wildlife Service 2001), its food habits remain only poorly known. Previous information on diet has been cursory (Beal 1912, Bent 1942, and McCabe 1991). To date, two descriptive diet studies have been conducted on the southwestern subspecies at several sites in California, Arizona and Colorado by the USGS Colorado Plateau Field Station (Drost et al. 1998, 2001). Based on analysis of fecal samples, those studies documented a wide variety of arthropod prey including both aquatic and terrestrial taxa. This variety of prey items suggests the Willow Flycatcher may be considered a generalist insectivore, but that characterization cannot be made without an understanding of prey availability. Whether or not the Willow Flycatcher is indeed a generalist or whether it specializes in particular prey has important implications for management, especially since observed diets varied among habitat types (Drost et al. 1998) and among sites (Drost 2001).

The largest breeding population of Willow Flycatchers in the Southwest is found in the Cliff-Gila Valley of southwestern New Mexico. The habitat used by breeding flycatchers at this midelevation site differs in a number of ways from elsewhere in the Southwest: the birds are concentrated in tall, mature riparian forests with box elder (*Acer negundo*) as a major component (Stoleson and Finch in review). Within this area, the density of flycatchers varies considerably among habitat patches. Proximity to water appears to be correlated with flycatcher abundance, although the underlying mechanism for this relation is unknown. Water may be required for essential prey items.

Here we describe the diet of the Southwestern Willow Flycatcher at this important breeding site. We also compare flycatcher diet to the composition of arthropods as sampled by sticky traps to test the hypotheses that (1) flycatcher diet reflects the relative abundance of different prey taxa (i.e., the bird is a generalist), and (2) flycatcher breeding densities are correlated with arthropod abundance and/or diversity within habitat patches. Finally, we compare flycatcher diet in the Cliff-Gila Valley to that reported from Roosevelt Lake in Arizona and the Kern River in California (Drost et al. 2001).

Study Site

The Cliff-Gila Valley of Grant County, NM, comprises a broad floodplain of the Gila River, beginning near its confluence with Mogollon Creek and extending south-southwest toward the Burro Mountains. This study was conducted primarily on the U Bar Ranch near the NM Route 211 bridge, as part of a larger, long-term project examining habitat use and demography of the Southwestern Willow Flycatcher and other riparian birds (Stoleson and Finch 1999, Stoleson et al. 2001).

The Gila River here is lined with riparian woodland patches of various ages and composition (Fig. 1). Most patches support a mature woodland (>25 m canopy) of Fremont cottonwood (*Populus fremontii*), with a subcanopy of mixed deciduous trees including box elder, Gooddings willow (*Salix gooddingii*), velvet ash (*Fraxinus velutinus*), Arizona walnut (*Juglans major*), Arizona sycamore (*Platanus wrightii*), Arizona alder (*Alnus oblongifolia*) and Russian olive (*Elaeagnus angustifolia*). The understory is composed of shrubs including three-leaf sumac (*Rhus trilobata*), false indigo (*Amorpha fruticosa*), New Mexico olive (*Forestieria neomexicana*), forbs, and grasses. Elevations range from 1350 to 1420 m.

Methods

Collection of diet samples

We collected fecal samples from adult Willow Flycatchers captured in mist-nets by their voluntary evacuation during net retrieval, processing (banding, measuring, etc.), and holding. After processing each bird, we held it in an opaque, well-ventilated cotton bag in an undisturbed location for at least 20 minutes before release. We collected additional fecal deposits opportunistically. Droppings were immediately placed in glass vials containing 70% Ethanol. Location, date, and sample number were written on each vial. Additional information on bird

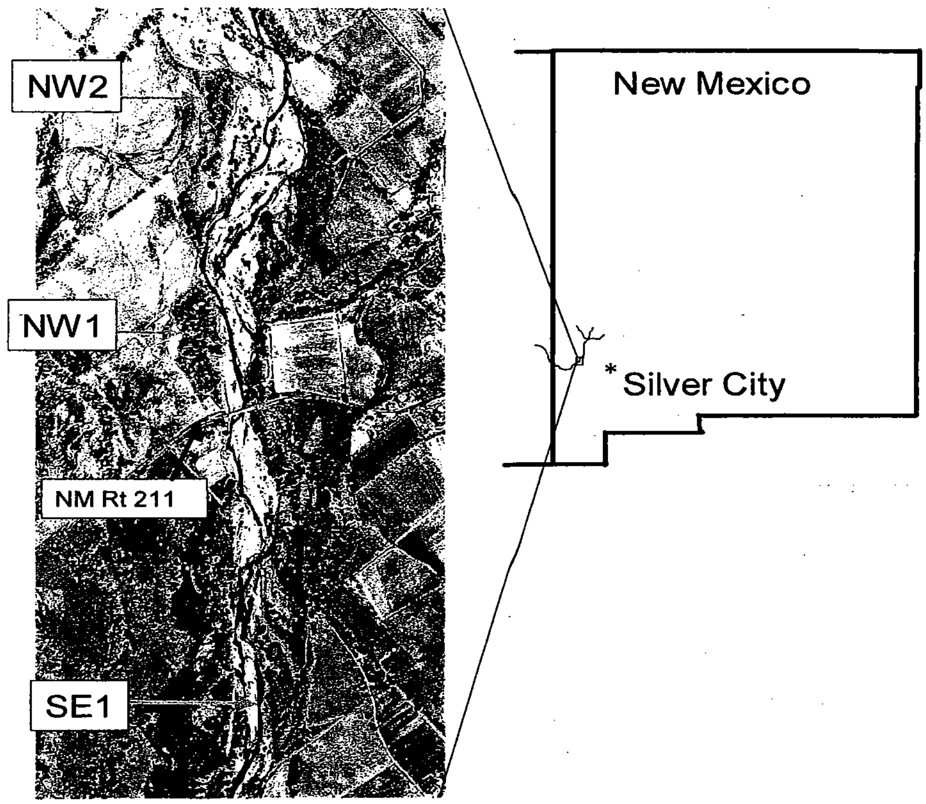

Figure 1. Location of Willow Flycatcher diet study site within New Mexico. Aerial infrared photo of a section of the Cliff-Gila Valley indicates the three riparian patches sampled for arthropods.

and habitat could be referenced from the sample number. A total of 23 fecal samples were collected during late May, late June and late July 1999.

Identification of diet samples

Individual samples were transferred to microscope dishes and examined under a 10-45x stereo-zoom microscope. Fragments of bodies, wings, legs, head capsules, mouthparts, or antennae were sorted, grouped, and identified to the finest taxon based on comparisons to reference arthropods and taxonomic literature. Our reference of distinguishable arthropod parts came from sweep-net samples of the foliage during the same dates. For each taxon, we estimated the minimum number of individuals represented based on recognizable parts (e.g. pairs of wings, or head capsules).

Statistical description of diet samples

We summarized diet samples in several ways: number of prey items per sample, number of different identified taxa per sample, number of each prey taxon across all samples, and percent occurrence (frequency) of each prey taxon in samples (proportion of samples in which a specific prey taxon was found). Small sample sizes precluded any statistical analysis of temporal trends within groups. For analyses we used and present information on the 6 most frequent arthropod orders, and pool all others as *other*.

Collection of arthropod samples

To sample the arthropod prey available within Willow Flycatcher habitat, we used sticky traps (Cooper and Whitmore 1990) placed in 3 different riparian patches in the Gila Valley. One patch (SE1) was adjacent to the Gila River, received irrigation runoff, contained a swampy wetland, and supported a very high density of flycatchers (7.7 pairs/ha). Another patch (NW1) was adjacent to the river and supported a low density of flycatchers (1.5 pairs/ha). The third patch (NW2) was distant (>200 m) from the river and other water sources and had no flycatchers. Otherwise, the woodlots were similar in size (4.2 – 5.1 ha) and vegetation composition and structure.

We randomly selected trees used for nesting by flycatchers in 1998 as arthropod sampling sites in SE1 (10 sites) and NW1 (8 sites). As the NW2 patch did not support breeding flycatchers, we selected 8 pseudo-nest trees based on a qualitative assessment of the available vegetation that was most similar to nest sites in occupied patches. All pseudo-nest trees selected in NW2 were box elders comparable in height (8-16 m) and structural complexity to those used in the other two patches.

For six weeks beginning 6/10/99, we placed 3 fresh sticky traps around nest trees each week based on the following protocol. A random azimuth and distance (between 0-15 m) from the nest tree were chosen to locate the first sticky trap. Second and third traps were placed at random distances (0-15 m) from the nest tree, at 120° and 240° from the first trap for maximum radial spacing between traps. Sticky traps were hung 1-2 m off the ground in the vegetation at each selected point using tiepins. For points lacking vegetation, we fastened traps approximately 1 m off the ground to wooden survey stakes inserted in the ground. Each trap was exposed for a period of 4 days, as test samples indicated at least some sticky traps approached saturation with arthropods after 4 days exposure.

Analyses

Overlap index

We used two indices to quantify dietary overlap: Horn's index and Pianka's index (Litvaitis et al. 1996). Drost's studies (1998, 2001) report only summary data, so we were unable to use the somewhat more precise Morisita's Index (Litvaitis et al. 1996). The formula for Horn's index is

$$R_o = \frac{\sum (P_{ij} + P_{ik}) \log (P_{ij} + P_{ik}) - \sum P_{ij} \log P_{ij} - \sum P_{ik} \log P_{ik}}{2 \log 2}$$

and that of Pianka's index is

$$O_{jk} = \frac{\sum P_{ij} P_{ik}}{\sqrt{\sum P^2_{ij} \sum P^2_{ik}}}$$

where P_{ij} = proportion order i is of total prey taken at location j, and P_{ik} = proportion order i is of total prey taken at location k. The formulae yield R_o and O_{jk}, estimates of the percent of diet overlap, at the taxonomic level of order, between flycatchers at locations j and k.

Comparison of diet to the Gila arthropod community. – We compared the proportions of arthropod orders detected in fecal samples to their proportions in sticky trap samples to assess whether prey items were taken in proportion to their abundance.

Comparison of diets among sites. – We compared Southwestern Willow Flycatcher diet in the Gila Valley to that reported from three other sites: the Kern River Preserve (n = 16 samples), the Salt River inflow to Roosevelt Lake (n = 11), and the Tonto Creek inflow to Roosevelt Lake (n = 9). All comparisons are based on fecal samples obtained from breeding adult flycatchers at each site. Data from the Kern Preserve and Roosevelt Lake sites come from Drost et al. 1998 and Drost et al. 2001.

Results

Willow Flycatcher diet on the Gila

Abundance of Prey Taxa. – Flying Hymenoptera (bees and wasps) constituted 42% of the identifiable insect remains in the fecal samples from the Gila Valley. Another 42% consisted of Hemiptera (true bugs), Coleoptera (beetles), and Diptera (true flies). The remainder of the fecal samples included ants (Hymenoptera), Homoptera (plant/leafhoppers), Thysanoptera (thrips), Odonata (damselflies, dragonflies), Neuroptera (lacewings, snakeflies), and miscellaneous material such as sand grains and willow flower parts (Table 1). Fifty-three percent of the Hymenoptera in our samples were a small bee (subfamily Apoidea, 1-2 mm in size). The remainder consisted of parasitic wasps such as cuckoo wasps (family Chrysididae), chalcid wasps (superfamily Chalcidoidea) and a medium sized sphecoid wasp, superfamily Sphecoidea.

The Hemiptera parts in the samples resembled those of seed bugs (family Lygaeidae) and leaf bugs (family Miridae). Coleoptera fragments found were less than 3 mm. Diptera identified were primarily of the suborder Nematocera that includes midges and gnats. A dance fly (family Empididae) was identified. Only two aquatic invertebrates were found, a damselfly and a lacewing (Table 1).

Table 1. Numbers and percent frequency of prey taxa in the diet of mist-netted Southwestern Willow Flycatchers from the Gila National Forest, New Mexico based on fecal samples collected during May to July, 1999 ($n = 23$ samples). Taxa are listed in descending order based on numbers of individuals identified in the samples. Category Other was excluded from percentage of prey. Frequency in samples (%) is the number and percentage of samples in which that taxon was identified.

Order	Common prey/ items	Number of prey (%)	Frequency in samples (%)
Hymenoptera	bees, wasps	25 (42)	12 (52)
Other	sand grains, willow flowers and pollen	16	3 (13)
Hemiptera	true bugs	10 (17)	8 (35)
Coleoptera	beetles	9 (15)	7 (30)
Diptera	true flies	6 (10)	5 (22)
Hymenoptera/ant	ant (wingless)	3 (5)	3 (13)
Homoptera/cicadellid	plant/leafhoppers	3 (5)	2 (9)
Thysanoptera	thrips	1 (2)	1 (4)
Odonata	damselflies, dragonflies	1 (2)	1 (4)
Neuroptera	lacewings, snakeflies	1 (2)	1 (4)
None	digested material	1	

Frequency of taxa in samples. – The frequency of diet items (proportion of samples in which a taxon was identified) followed a pattern similar to the abundance of taxa among all samples. Hymenoptera was the most widespread order, being found in over half of all samples. The other most frequent taxa were true bugs (Hemiptera), beetles (Coleoptera), and true flies (Diptera) (Table 1).

Arthropod Community Structure on the Gila

Sticky trap samples at all three Gila sites were overwhelmingly dominated by thrips (Thysanoptera). Other predominant orders were Diptera, Hymenoptera, Coleoptera, Homoptera, and Araneae (Table 2).

The proportion of arthropod orders among Cliff-Gila sample sites was very similar: each pair of sites had >88% overlap (Table 2). The proportion of arthropod orders at the site with the high WIFL density (SE1) was most similar to that at the dry no-WIFL site (NW2), with an overlap index of 90%. The SE1 site showed slightly lower overlap with the intermediate site (NW1), but overall there was no statistically significant difference among sites in the proportion of arthropods among orders ($\chi^2 = 9.7$, df = 12, $P = 0.64$).

Table 2. Numbers (and percentages) of arthropods collected in sticky traps at three sites in the Cliff-Gila Valley, N.M. The three sites supported high density (SE1), low density (NW1), and no Southwestern Willow Flycatchers. Taxa are listed in the same order as in Table 1.

		Site					
Order	Prey Type	SE1		NW1		NW2	
Hymenoptera	bees, wasps, ants	1,084	(4.8)	1,485	(9.1)	1,516	(8.1)
Hemiptera	true bugs	228	(1.0)	138	(0.8)	69	(0.4)
Coleoptera	beetles	830	(3.6)	1,332	(8.2)	1,026	(5.5)
Diptera	true flies	3,208	(14.1)	3,369	(20.7)	2,927	(15.7)
Homoptera/cicadellid	plant/leafhoppers	1,013	(4.4)	941	(5.8)	619	(3.3)
Thysanoptera	thrips	15,990	70.3	8,423	(51.8)	12,011	(64.4)
Odonata	damselflies, dragonflies	0	(0)	0	(0)	0	(0)
Neuroptera	lacewings, snakeflies	0	(0)	7	(<0.1)	2	(<0.1)
Aranaea	spiders	223	(1.0)	308	(1.9)	226	(1.2)
Other	all other	182	(0.8)	276	(1.7)	261	1.4

The numbers of arthropods sampled by sticky traps did vary significantly among the three Gila sites and over time (ANOVA with site and week as classifying factors: $F_{16, 21761}$, $P < 0.01$). Post hoc tests (Bonferroni) indicated arthropod numbers were significantly greater in SE1 than in NW2, and significantly greater in NW2 than in NW1 (see Table 2). These results were similar whether thrips were included in analyses or not. Numbers of Hymenoptera, the most common prey taxon, were inversely correlated with flycatcher density: SE1 had the fewest and NW2 had the highest numbers.

Because there were no significant differences in the proportions of prey taxa among the Cliff-Gila sample sites, we compared our diet samples to a composite arthropod community from all 3 sites.

Comparison of flycatcher diet with the Gila arthropod community

The proportions of arthropod orders represented in the diet samples differed significantly from the proportions determined from our sticky traps ($\chi^2 = 113.2$, df = 7, $P < 0.001$). The degree of overlap between diet and sticky traps was only 45% based on Horn's index, and only 21% based on Pianka's index.

Thrips made up an overwhelming proportion of the arthropods in our sticky traps, yet appeared to be taken only rarely by the flycatchers (Tables 1 & 2). It may be inappropriate to consider thrips as available prey since the birds rarely took them, and to do so is likely to skew comparisons of diet and available arthropods. We therefore compared the proportion of arthropod orders in flycatcher diets and sticky traps excluding thrips from both samples. Again, the diet differed significantly from the traps ($\chi^2 = 51.0$, df = 6, $P < 0.001$). The degree of overlap was 67% by Horn's index, and 60% by Pianka's. Both Hymenoptera and Hemiptera were over-represented in the diet samples compared to the sticky traps (Figure 2). Homoptera and Diptera were disproportionately scarce in the diet samples. Coleopterans were taken in proportion to their abundance.

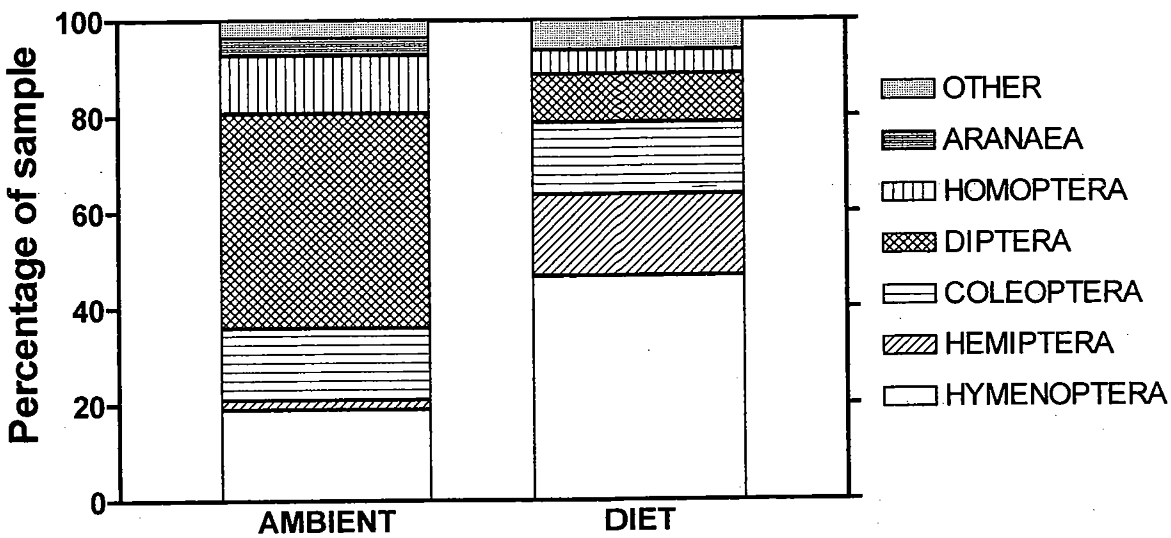

Figure 2. Proportions of major arthropod orders in Southwestern Willow Flycatcher diet (2) and the arthropod community as sampled by sticky traps (1). These graphs exclude thrips (Thysanoptera); differences are exaggerated when thrips are included.

Willow Flycatcher Diet Among Breeding Sites

The composition of Willow Flycatcher diets was only moderately similar among breeding sites: levels of overlap ranged from 71% to 83% based on Horn's index, and 52% to 84% based on Pianka's index (Table 3, Figure 3). The Gila differed significantly from the other three sites (all $\chi^2 \leq 29.0$, df = 6, $P < 0.001$). Diet on the Gila was most similar to that on the Tonto, and most different from the Kern Preserve (Figure 2). The two sites on Roosevelt Lake (Tonto and Salt) were the most similar to each other (Table 3).

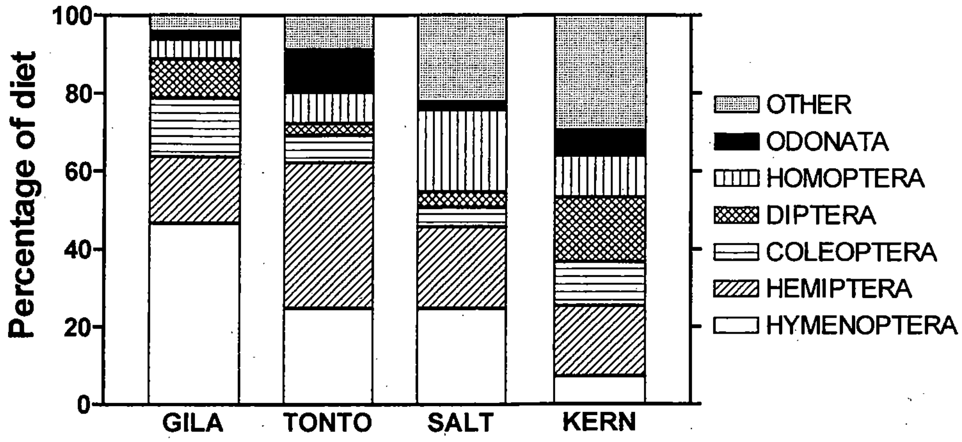

Figure 3. Proportions of major arthropod orders in the diet of Southwestern Willow Flycatchers at (1) Cliff-Gila Valley, NM (2) Tonto Creek inflow to Roosevelt Lake, AZ, (3) Salt River, AZ, and (4) the Kern River, CA.

Compared to other sites, Gila birds preyed to a much greater extent on bees and wasps. Remains of these Hymenoptera groups were found in 52% of Gila samples, versus 36% of Kern samples. Data on frequency of prey items in samples are not available for the Arizona sites, but flying Hymenoptera were the most abundant taxa among all prey items recorded from the Salt, and the second most abundant from the Tonto (Drost et al. 2001). Beetles (Coleoptera) also made up a proportionally larger share of the diet on the Gila than elsewhere. In contrast, the proportion of leafhoppers and other Homopterans in the flycatcher diet was lowest among the Gila birds. Still, the distribution of arthropod orders in the diet of Willow Flycatchers on the Gila was more similar to that in diets in Arizona than it was to the general arthropod community from which it was taken on the Gila.

Table 3. Estimates of diet overlap among four Willow Flycatcher sites based on Horn's index (upper right), and Pianka's index (lower left).

	KERN	SALT	TONTO	GILA
KERN	-	0.82	0.77	0.71
SALT	0.82	-	0.83	0.78
TONTO	0.62	0.84	-	0.81
GILA	0.52	0.76	0.79	-

The Kern samples contained a variety of arthropod taxa not found in the Gila samples, despite our larger sample sizes. We found no recognizable termites (Isoptera), spiders (Araneae), moths and butterflies (Lepidoptera), isopods (Isopoda), or mites (Acari) in the Gila diet samples, although Lepidoptera, mites, and spiders were found in sticky trap samples.

Discussion

Willow Flycatcher diet in the Cliff-Gila Valley

We found that in the Cliff-Gila Valley, NM, flying Hymenoptera (non-ants) were the most abundant and widespread taxon throughout our samples, making up almost half of the identifiable prey items. True bugs (Hemiptera), beetles (Coleoptera), and true flies (Diptera) also ranked high in total numbers and in frequency of occurrence in flycatcher diet.

Aquatic arthropods were not well represented in our fecal samples: only 2% Odonata (damselflies, dragonflies) compared to the 7% found in mixed riparian of samples of Arizona and Colorado (Drost et al. 1998). Cliff-Gila samples also lacked lepidopteran larvae, Trichoptera, Ephemeroptera, and non-insects such as spiders (Araneae) and pill bugs (Isopoda).

Comparison of Willow Flycatcher diet among breeding sites

The diet of Willow Flycatchers varied among the four breeding sites. Several taxa predominated in the diet at all sites (Hymenoptera, Hemiptera, Diptera, Coleoptera). The Hymenoptera constituted a much larger proportion of the diet in Gila birds than elsewhere. Although such a result might occur if the Gila was less diverse than the other sites, this seems unlikely. The riparian vegetation on the Gila is relatively speciose compared to the other sites (Sogge and Marshall 2000), and thus likely to support a more diverse assemblage of prey taxa. In particular, the Roosevelt Lake sites are dominated by exotic salt cedar, which may support lower arthropod diversity and density (DeLay et al. 1999). One notable exception is the leafhoppers (Homoptera:Cicadellidae), which are relatively abundant and diverse in saltcedar, and were significantly more prominent in the diet at Roosevelt Lake (Drost et al. 1998, 2001). Overall the Gila diet resembled that on the Kern in the relatively higher use of Dipterans and Coleopterans, but was more like the Salt River in low use of Odonates. Gila birds apparently did not prey on Isopterans (termites) or Araneaens (spiders); this may reflect the fact that flycatchers on the Gila tend to be high up in the subcanopy as opposed to in the understory as in other sites, or may be an artifact of small sample sizes.

Are Southwestern Willow Flycatchers generalist foragers?

Every arthropod sampling method has inherent biases as to which types of prey it samples well (Cooper and Whitmore 1990, Poulin and Lefebvre 1997). Sticky traps primarily sample flying insects, and tend to sample only poorly such non-volant groups as lepidopteran larvae and mites (Cooper and Whitmore 1990). However, as Willow Flycatchers are primarily aerial foragers (Sedgwick 2000), we feel it is reasonable to assume that the arthropods sampled by sticky traps were representative of those taxa most available to flycatchers foraging within the study site.

We found significant differences between the relative abundance of arthropods within the Cliff-Gila Valley sampling sites and their relative abundance in the fecal samples, whether we included thrips in analyses or not. The Hymenoptera made up over 47% of the prey items, but constituted less than 10% of the arthropods caught on sticky traps (19% without thrips). Similarly, Hemipterans made up 17% of the diet, but constituted less than 1% of the available prey (2% without thrips). In contrast, 14-20% of sticky trap arthropods were Dipterans (45% excluding thrips), yet accounted for only 10% of the diet.

Thus, it appears that Willow Flycatchers on the Gila do not take arthropod prey in proportion to their availability. This suggests that the flycatcher may not be a generalist insectivore. Rather, flycatchers may be preying selectively on Hymenoptera and Hemiptera at this site. For example, the high use of Hymenoptera we found is not simply because bees and wasps are particularly abundant and visible – no butterflies or moths were represented in fecal samples, although they are a much more conspicuous component of the diurnal aerial arthropod fauna (pers. obs.). It is noteworthy that aquatic arthropods made up only a very small fraction of the flycatcher diet, suggesting that the flycatcher's strict association with water is not food-based.

This conclusion is supported by the observation that the diet on the Gila was more similar to that recorded at other sites in the Southwest, including the very different Roosevelt Lake sites that are dominated by non-native saltcedar, than to the general arthropod community on the Gila. It seems likely that saltcedar habitats support a very different, and probably less diverse, arthropod community than does the mixed native riparian habitat on the Gila, as has been reported from saltcedar habitats on the Rio Grande in New Mexico (DeLay et al. 1999). Similarities in diet among sites are unlikely to be due to similarities in arthropod communities, but more likely due to similar prey selectivity among flycatchers at those sites.

It should be noted that our assessment of availability may better reflect what arthropods are present at the site rather than what is actually available to foraging flycatchers (Wolda 1990). It is unclear whether those taxa under-represented in the diet (e.g., thrips) might be less available to flycatchers than suggested by trap data because of behavioral or life history traits. For example, nocturnally active insects would be well sampled by sticky traps but may be only rarely found by diurnal flycatchers. Alternatively, certain prey types may be unpalatable and therefore taken only infrequently. Further research needs to be conducted on potential factors such as these that might affect our comparisons.

Does prey availability determine Willow Flycatcher density?

We found no significant differences in the proportions of arthropod orders among the three Gila sampling sites (Table 2). Further, although the absolute numbers of arthropods collected varied among sites, that pattern of variation did not correspond to flycatcher numbers. The site with the fewest arthropods (NW1) supported moderate numbers of flycatchers, while the site with intermediate levels of arthropods (NW2) had none. Also, the abundance of Hymenoptera, the most frequent prey taxon in the Cliff-Gila Valley, was inversely related to flycatcher density – the site with high numbers of flycatchers (SE1) had the lowest counts of Hymenoptera. These results argue that food availability *per se* is not responsible for the observed variation in flycatcher numbers among sites in the Cliff-Gila Valley.

Conservation and management implications

Southwestern Willow Flycatchers take a wide variety of arthropod prey. Although dominated by flying insects, they also take terrestrial forms (wingless ants in this study; termites, mites, and spiders in the Arizona and Kern studies). Although flycatchers are strongly associated with water, invertebrates with aquatic stages make up only a minor component of their diet.

Despite the apparent diversity of prey items taken by the Cliff-Gila population, our results suggest the birds may not be true generalists, but rather seem to be selective in their prey choice. Their high use of relatively mobile bees and wasps suggests they may be vulnerable to accumulation of pesticides from prey that range into agricultural areas adjacent to riparian zones (Paxton et al. 1997).

Prior descriptive studies of flycatcher diet suggested flycatchers might not be limited by food, based on the diversity of prey items identified (Drost et al. 1999, 2001). We found no evidence that flycatchers in the Cliff-Gila Valley were limited by food in 1999. However, we believe that if flycatchers are indeed specializing on certain prey taxa, they could be vulnerable to stochastic or deterministic declines in the abundance of those taxa. We strongly encourage additional research on flycatcher diet to assess both prey use and availability. This research should be conducted at multiple sites, including areas dominated by native and exotic vegetation.

Acknowledgments

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